INFLUENCE OF AGE AND GIRTH AT OPENING ON BIOCHEMICAL AND TAPPING PANEL DRYNESS PARAMETERS OF *HEVEA BRASILIENSIS* IN DETERMINING TAPPING NORMS

Criteria of age for *Hevea brasiliensis* tapping norms

Obouayeba S., Kouamé C., Boa D., Dian K., Aké S. and Lacote R.

Obouayeba Samuel : CNRA (Centre National de Recherche Agronomique), station de recherche de Bimbresso, 01 BP 1536 Abidjan 01, Côte d'Ivoire

Dian Kouadio : CNRA (Centre National de Recherche Agronomique), Laboratoire Centrale de Biotechnologie, 01 BP 1740 Abidjan 01, Côte d'Ivoire

Kouamé Christophe : CNRA (Centre National de Recherche Agronomique), Direction régionale d'Abidjan, 08 BP 33 Abidjan 08, Côte d'Ivoire

Boa Daniel : CNRA (Centre National de Recherche Agronomique), Direction régionale d'Abidjan, 08 BP 33 Abidjan 08, Côte d'Ivoire

Aké Sévérin: UFR-Biosciences Université de Cocody, Abidjan, Côte d'Ivoire

Lacote Régis : CIRAD (Centre de Coopération Internationale en Recherche Agronomique pour le Développement) 01. B.P. 6483 Abidjan 01, Côte d'Ivoire

Obouayeba Samuel : CNRA (Centre National de Recherche Agronomique), station de recherche de Bimbresso, 01 BP 1536 Abidjan 01, Côte d'Ivoire

Abstract

The incidence of several girths and/or delay of opening on *Hevea brasiliensis*, physiological state and sensitivity to tapping panel dryness have been studied during ten years in the south-eastern rubber growing area of Côte d'Ivoire. The study was conducted on clones GT 1, PB 217 and PB 235 submitted to early tapping (opening at 40 and 45 cm of girth) and/or late tapping (opening at 55, 60 and 65 cm of girth). Data on agronomic, physiological and tapping panel dryness parameters suggest that tapping of clone GT 1 at 40 and 50 cm of girth and tapping of clones PB 217 and PB 235 at 50 cm are the best treatments. These girths at opening were reached about six year after planting, whatever the clone. The satisfactory results obtained, in spite of one-year delay in growth, demonstrate the preponderance of opening age notion over girth of tapping. Similarly, the age of 6 years after planting seems objectively the best time for opening rubber tree, because it constitutes a good physiological reference of *Hevea brasiliensis* maturity.
Key words: Girth, *Hevea brasiliensis*, Tapping, Tapping Panel Dryness, Six years after planting, Early and late tapping, Physiological maturity

Résumé

L'incidence de plusieurs circonférences ou délais de mise en saignée sur les paramètres du profil physiologique et de la sensibilité à l'encoche sèche d'*Hevea brasiliensis* a été étudiée pendant une dizaine d'années dans le sud-est hévéicole de la Côte d'Ivoire. L'étude a été réalisée à partir de saignées dites précoces (mise en saignée à 40, 45 cm de circonférence) et/ ou tardives (ouverture à 55, 60 et 65 cm de circonférence) appliquées aux clones GT 1, PB 217 et PB 235. Cette étude montre que la mise en saignée du clone GT 1 à 40 cm de circonférence et des clones PB 217 et PB 235 à 50 cm constituent les meilleurs traitements du point de vue des paramètres physiologiques et de l'encoche. Ces circonférences à l'ouverture ont été obtenues à environ 6 ans après la plantation, quel que soit le clone. Les résultats satisfaisants enregistrés montrent la prépondérance de la notion "âge d'ouverture" sur celle de circonférence de mise en saignée. Ainsi, l'âge de 6 ans après plantation semble être le meilleur délai de mise en saignée des hévéas, parce qu'il constitue un bon repère de maturité physiologique chez *Hevea brasiliensis*.

Mots clefs : Circonférence / ***Hevea brasiliensis*** / Six ans après plantation / Saignée / Encoche

sèche / Saignées précoce et/ou tardive / Maturité physiologique

INTRODUCTION

There exists an antagonism between the biomass production through vegetative growth of *Hevea brasiliensis* and exploitation of the trees for crop production by tapping (6, 15, 24, 25, 26, 27). Thus higher initial yield may lead to lower vegetative growth and future yield potential and productivity (4, 27). A good tapping policy result in a good balance between annual girth and yield (26) so that the primary biomass production is less affected (24). This will ensure proper physiological functioning of the trees. The girth at opening is of significance in this context and lower girth is an indication of slower growth and maturity (2, 16). The good growth is an exterior indication of physiological equilibrium profile, a good health sign of Hevea, sine qua non conditions of higher productivity during the economic life of threes (6). Girths and or delays of opening are of great importance among the tapping system components for obtaining the better equilibrium between both metabolisms. The girths introduce, in fact, earlier tapping notion according to empirical criteria (2). It consists of opening for tapping when the girth of the tree reaches 50 cm at 1 m from the ground. In the same way, the delays would be permitted to take into account the slowness growth notion (2, 17).

This study was aimed, after the evaluation of the effect of rubber production and radial vegetative growth (16), at analyzing the effect of girth and/or age at opening on latex biochemical and tapping panel dryness parameters in three *Hevea* clones (PB 235, GT 1 and PB 217) grown in the south eastern region of Cote d'Ivoire.

MATERIAL AND METHODS

Plant material

Three clones of *Hevea brasiliensis* widely cultivated in Côte d'Ivoire with rapid (PB 235) moderate (GT 1) and low (PB 217) metabolic activity of laticiferous system were included in this study (1, 11, 23). Based on vegetative growth, the clones belong to fast (PB 235) and moderate (GT 1 and PB 217) growing categories (17, 18, 21).

Methods

Choice of trees and experimental design

Orientation experiments (preliminary)

Four trials (Experiments 1 and 5, Experiment 2 and Experiment 3) were carried out with clones GT 1, PB 217 and PB 235, planted at the density of 510 trees/ha (7 m x 2.80 m). At the start of the trials, the average girth of trees was 39.64 cm, 2 % < CV <4 %. The treatments allowed involving 33 randomly distributed trees on 3.12 ha of surface where the choice concerns the trees not affected by *Fomes lignosu*s.

Agronomic experiments

In this kind of trial (experiment 4), only clone PB 235 is tested. It has been planted at density of 510 trees/ha: 7 m x 2.80 m. The average girth was 51 cm, with about 5 % of coefficient of variation. The trees affected or not by *Fomes lignosus* and neighbouring trees were not included in the experiment. Three treatments were studied in block of Fisher with four repetitions. Each repetition contains 95 trees or 1140 trees for the whole trial.

Parameters measured

In all treatments except the control, tapping was done on a ½ S d/4 6d/7 ET 2.5 % Pa 1(1) 2 to 8/Y system (5). The production is collected tree by tree (Preliminary trials)

by elementary plots (Agronomic trial), every four weeks or at every six tapping. During the estimation of production, a fresh coagulum sample is deducted from each treatment (2 kg). From this sample, the coefficient of transformation (CT) permits to determine, on fresh weight basis, the dry rubber production in cumulated gram per tree (g/t) and in kg per ha per year (kg/ha/y). The following parameters were also annually measured:

- Measures of girth at 1.70 m of ground for each tree of the trials then also in industrial plantations. These measures allowed, according to growth models established by Obouayeba *et al* (17) to estimate the effects of tapping at various girths at opening of Hevea.
- Tapping panel dryness lists for the determination of rates of partially dry (PDR) and totally dry tree (TDR).

Collected latex was used in physiological parameters and analysis: dry rubber content (DRC), sucrose (Suc), inorganic phosphorus (IP) and thiols (R-SH) contents. This analysis and its interpretation was realised by "micro diagnostic latex (MDL) method (11, 13). In practice, one ml of each latex sample treatment is weighted before and after 24 hours drying in an oven the difference of weight expressed in percentage gives the dry rubber content (DRC). The organic phosphorus (IP), sucrose (Suc) and the thiols grouping (R-SH) are measured on the basis of trichloroacetic acid serum (TCA). This serum is obtained by mixing 1 ml of latex and 9 ml of TCA 2,5 %. The use of a stick helps to express coagulated rubber from TCA 2,5 % (11, 13, 23).

Statistical analysis

Statistical analysis concerned the data of production, physiologic parameters as the sucrose, dry rubber content, inorganic phosphorus, R-SH grouping and the partially and or totally dryness rate of trees.

RESULTS

Rubber Yield

The cumulated yield (g/t) of clone GT 1 is significantly, as lower as the girth at opening was smaller (Table 1). Whatever the clone, when opening is realized once and after of 50 cm (or at 6 years), the g/t is not discriminate of the girths at opening since six seasons of tapping, for difference of two years between two delays of opening.

By another way, during the first tapping years, the time of exploitation or the cumulative number of tapping seems the principal criteria of discrimination of treatments. In fact, there were observed, on clones GT 1 and PB 235, that when the opening delay between treatments exceed two years, the cumulated g/t of first opening treatments is higher than to the last, during after 6 seasons. This advance becomes indistinct since the 7^{th} season of tapping. That is confirmed by results of production, g/t, of five experiences (trials).

Biochemical parameters of latex

Clone GT 1

The clone GT 1 presents, whatever the trial, at the opening a general rate mean level of dry rubber content (DRC) and according to the norms but for certain treatments this rate knows a relative increase with the tapping (*Figures 1a and 1b*). Except the

control, the rates of dry rubber content don't vary significantly between treatments tapped whatever the moment at tapping. However, one notes that, whatever the experience, the rates of dry rubber content, according to the girth at opening, have an opposed evolution between the beginning and the end of experiences.

The sucrose content has also a good level and doesn't vary with the girth. Excepted the control, untapped treatment, (*Figure 1b*), whom the value is decreased at the end of trial, all treatments are presented high final contents.

For the Pi, the final contents are generally increased according to initial values for experiment 5. In experiment 1, the final contents are decreased. Globally, the final content, in Pi, is satisfactory[17] and corresponding to that of GT 1. It was generally known a fluctuation liked at girths of opening. In the first trial, the activation level, illustrated by the Pi, of treatment opened at 50 cm is higher than that of trial 5.

Concerning thiols grouping, a general decrease of contents was noted according to start values of trial. This decrease cannot attribute at the first tapping (opening) because it is also observed with the control, untapped treatment (Experiment 5). The content in thiols grouping (R-SH) is corresponding to that of clone GT 1. It has variations liked at treatment but who don't generally produce a negative effect at treatments opened at 6 years after planting (Tables 1 and 2).

Clone PB 217

The rate of dry rubber content distinguishes two groups of treatments (*Figure 2*). The first concerns the openings at 50 and 55 cm, which the rates were statistically identics. These rates are higher than that of second group, openings at 60 and 65 cm, with the comparable rates.

The sucrose content is higher level, except treatment 2, opening at 55 cm of girth, which the content is significantly inferior to that of others, comparable contents.

For the Pi content, the opening at 50, 55 and 60 cm was not statistically different but lowers from that of opening at 65 cm. Globally, the level is satisfactory according to characteristics of clone PB 217.

The thiols grouping content don't distinguishes the openings at 50, 60 and 65 cm which values are the same importance and superior to that of opening at 55 cm.

Clone PB 235

The final mean rate of dry rubber content of clone PB 235, whatever the trial, is satisfactory. The dry rubber content is influenced by the opening girth. The mean rate of dry rubber content has known a significantly increase during the time for treatment opened at 40 and 45 cm of girth and decrease for the treatment tapped at 55 and 60 cm (Experiment 3). The biosynthesis activity of rubber was not discriminated of treatments, so the tapping obviously in proved it.

The sucrose content of various openings, except that of treatments 2 and 5, is lower level (Experiment 3). Concerning the experiment 4, the sucrose content is particularly good and according to the annual production of treatments. The first two treatments are comparable contents and superiors to that of least. Yet, globally, it is in high increase and the final values are superior to that of clone PB 235 (*Figures 3*).

The Pi content (Experiment 3) has varied according to the time and the opening girth. Only the last opening has a lower final content (*Figure 3*). This increase is more important in case of first treatment, probably for its long period of tapping (*Figure 3b*). This Pi increase is little for the last treatment. Whatever the experience, the Pi content is conformable to tapping characteristics of clone PB 235.

The thiols grouping content (R-SH) is, whatever experience, generally mean and according to that of clone PB 235. It has globally decreased in the time. Yet, all girths

at opening, irrespectively the experience are statistically comparable according to their thiol content.

Tapping Panel Dryness

Clone GT 1

Generally, according to initial rates of partial and total dryness of trees, the first experience shows (Table III) a significantly increase of tapping panel dryness rate. This increase is as much as important than the tapping were earlier. For experience 5, the treatments tapped at 40 and 45 cm of girth manifested globally less sensitivity to the dryness of tapping cut and the others high value of dryness rates (Table II).

The treatment tapped at 50 cm, relative control, is more sensitive that opened at 45 cm. This tapping panel dryness and rubber production result globally satisfactory leads to choice the treatments opened at 40 and 50 cm of girth, respectively at 6 years and 5 years nine months, for the best. They are, in fact, present good productions without pernicious incidence on vegetative growth that is suitable with an equilibrium physiological profile and less sensitivity to tapping panel dryness.

Clone PB 217

All the treatments are manifested the low sensitivity to tapping panel dryness (Table III). These results indicate that the more interesting treatment is the opening at 50 cm at least 6 years after plantation. For it good production with very well equilibrium physiological profile and weak sensitivity to tapping panel dry according to characteristics of PB 217.

Clone PB 235

There is more sensitivity to tapping panel dryness (Experiment 3) especially concerning partially dry (PDR). It varies with the girth at opening (Table 3). The relative control (opening at 50 cm of girth) manifests highest sensitivity. For total dry, all treatments give dry trees with rate according to sensitivity of clone PB 235. Concerning experiment 4, there was noted the same evolution and final state for the totally dry of tress. In case of partially dry, the first two treatments are statistically comparable and lower than to third treatment. It presents a rate dry tree higher than of last treatment (Table V).

According to results of production, growth, physiological profile and sensitivity to tapping panel dryness, opening of PB 235 at 6 years old, seem the best treatment.

DISCUSSION

The aim of this study is to evaluate the effect of tapping at various girths on the physiological status of trees. Because, in the first part of this study, the result of rubber production and vegetative growth have shown that the earlier tapping reduce the production and the girth during tapping (8, 9, 10, 16, 26, 27).

The competition between the rubber yield and vegetative growth is higher in earlier tapping systems. However, when the tapping is realized 6 years after planting, the rubber production and vegetative growth during tapping are good (18, 22). Because the couple production-vegetative growth seem well equilibrium. That is due to the feeble sensitivity to tapping panel dryness corroborated by the equilibrium physiological profile without physiological sign of fatigue (12, 18). So, for the clone GT 1, the tapping 6 years after planting and at 40 cm of tree girth give the same effect

to that of the tapping at girth superior or equal to 50 cm of tree girth which corresponding to opening at least 6 years. For the clone PB 235, when the tapping is done at least 6 years and at 50 cm of tree girth, this is equivalent to tapping at girths superiors or equal at 60 cm.

Further, the best treatments according to production and vegetative growth during tapping are the opening at 40 an 50 cm, which has been tapped, at delay ranged from 5 years nine months to 6 years ten months, whatever clone and trial.

Finally, the recorded results show that all treatments opened at 50 cm of girth, whatever clone, have a well equilibrium physiological profile (3, 7, 11). This is corroborated by globally lower rates of tapping panel dryness than that noted with others treatments (27).

For the opening at 40 cm of girth on clone GT 1, the physiological profile is among the better equilibrium and according to that of clone, with a lower sensitivity to the tapping panel dryness (12).

All the results clearly indicate that at 6 years after plantation, tapping rubber tree, whatever the studied clone, ensure the better levels of vegetative growth and production (14, 18). Therefore, it does not especially induce physiological problems but what is better, it confers trees enough well physiological equilibrium profile, that the maturity qualified “tapping maturity” can be also called “physiological maturity”. Therefore, this shows veritably and proves the well criteria objective of tapping Hevea is the age, in particular 6 years after plantation. The preponderance of criteria "age to opening” on that of "girth to opening" is proved.

CONCLUSION

The incidence of several girths or delays at opening on physiological profile and tapping panel dryness sensitivity shows that 40 and 50 cm of GT 1, PB 217 and PB 235 are the better treatments according to the rubber production, vegetative growth during tapping, physiological profile and sensitivity to tapping panel dryness. Different delays corresponding to this girth at opening were permitted to remark that it was reached at about 6 years after plantation, whatever the vegetative growth class. To know the growth showiness, of at least one year, of clones GT 1 and PB 235, the preponderance of the notion "opening girth" can be admitted. About the same, the age of 6 years after plantation seems the better delay of opening of Hevea, because it is same for the three vegetative growth classes of studied clones and would be constituted a good physiological maturity reference of *Hevea brasiliensis*.

REFERENCES

1. CIRAD-CP, 1993. Fiches de clones 4, 11 and 12 : GT 1, PB 217 et PB 235. *In : Recueil de Fiches de clones unpublished information* 5 p.

2. COMPAGNON P., 1986. Principes de la conduite de l'exploitation. *In*: Le caoutchouc naturel, Coste R. ed., G.P. Maisonneuve and Larose, Paris, 237-265.

3. ESCHBACH J.M., VAN DE SYPE H. AND JACOB J.L., 1984. Relationships between yield and clonal physiological characteristics of latex from *Hevea brasiliensis*, Physiologie Végétale, **22**, 295 p.

4. GOHET E., 1996. La production de latex par Hevea brasiliensis. Relation avec la croissance. Influence de différents facteurs : Origine clonale, stimulation hormonale, réserves hydrocarbonés. Thèse de doctorat d'Université, Université Montpellier II – Sciences et Techniques du Languedoc, France, 343 p.

5. GOHET E., LACROTTE R., OBOUAYEBA S. AND COMMÈRE J., 1991. Tapping systems recommended in West Africa. *Proceeding of Rubber Growers' Conference, Rubber Research Institute of Malaysia*, ed., Kuala Lumpur, Malaisie.

6. GOHET E., PREVOT J.C., ESCHBACH J.M., CLÉMENT A. AND JACOB J.L., 1996. Clone, croissance et stimulation, facteurs de production de latex. *Plantations, recherche, développement*, **3 (1)**, 30-38.

7. GOMEZ J.B., 1983. Physiology of latex (rubber) production. *Malaysian Rubber Research and Board (MRRDB), Monograph n°8*, Kuala Lumpur, 117 p.

8. IRCA 1987. Rapports annuels : Systèmes d'exploitation adaptés aux clones, saignée précoce, 113-115.

9. IRCA 1988. Rapports annuels : Systèmes d'exploitation adaptés aux clones, saignée précoce, 104-105.

10. IRCA 1989. Rapports annuels : Systèmes d'exploitation adaptés aux clones, saignée précoce, 97-98.

11. JACOB J.L., ESCHBACH J. M., PREVOT J.C., ROUSSEL D., LACROTTE R., CHRESTIN H. AND D'AUZAC J., 1985a. Physiological basis for latex diagnosis of the functioning of the laticiferous system in rubber trees. *Proceeding of Rubber Conference, Rubber Research Institute of Malaysia*, ed., Kuala Lumpur.

12. JACOB J.L., PREVOT J.C. AND LACROTTE R., 1994. L'encoche sèche chez *Hevea brasiliensis.* Plantations, recherche, développement, **1(3)**, 15-24.

13. JACOB J.L., SERRES E., PREVOT J.C., LACROTTE R., CLEMENT-VIDAL A., ESCHBACH J.M. AND D'AUZAC J., 1988. Mise au point du diagnostic latex. *Agritrop*, **12**, 97-118.

14. NARAYANAN R., HO C.Y. AND CHEN K.T., 1974. Clonal nursery studies in Hevea. III Correlations between yield, structural characters, latex constituents and plugging index. *Journal of Rubber Research Institute of Malaya*, **24 (1)**, 1-14.

15. NARAYANAN R, HO C.Y., 1973. Clonal nursery studies in Hevea. II Relationship between yield and girth. *Journal of Rubber Research Institute of Malaya*, **23 (5)**, 332-338.

16. OBOUAYEBA, S., BOA, D. AKE, S. et LACOTE, R. (2002) Influence of age and girth at opening on growth and productivity of Hevea. *Indian Journal of Natural Rubber Research*, 15(1) 66-71.

17. OBOUAYEBA S., BOA D., GOHET E., DIAN K., OUATTARA N. AND KELI J., 2000. Dynamics of vegetative growth of *Hevea brasiliensis* in determining tapping norms. J. Rubb. res. **3 (1)**, 53-62.

18. OBOUAYEBA S., BOA D. AND JACOB J.L., 1996b. Les performances du clone d'hévéa *PB 217 en Côte d'Ivoire.* Plantations, recherche, développement, ***3 (5)**, 346-354*.

19. OBOUAYEBA S., BOA D. AND KELI Z. J., 1996a. Adéquation entre quantité de pâte stimulante et production de caoutchouc d'Hevea brasiliensis dans le sud-est de la Côte d'Ivoire. TROPICULTURA, **14 (2)** 54-58.

20. OBOUAYEBA S., AND BOA D., 1993. Fréquence et repos annuel de saignée d'Hevea brasiliensis, clone PB 235, dans le sud-est de la Côte d'Ivoire. Cahiers Agricultures, **2 (6)**, 387-393.

21. OUATTARA N., 1998. Contribution à la détermination d'une norme de mise en saignée d'*Hevea brasiliensis* en Côte d'Ivoire : cas du clone GT 1. Mémoire de fin d'études pour l'obtention du Diplôme d'Agronomie Approfondie (D.A.A). Option production végétale (Agronomie), 33 p.

22. PREMAKUMARI D., PANIKKAR A. O. N., MARATTUKALAM J.G. AND SETHURAJ M. R. 1996. Yield and anatomical characters in Hevea: A path coefficient analysis and characterisation of clones. *Indian Journal of Natural Rubber Research* **9 (1)**, 12-16.

23. PREVOT J.C., JACOB J.L., LACROTTE R., VIDAL A., SERRES E., ESCHBACH J.M. AND GIGAULT J., 1986. Physiological parameters of latex from *Hevea brasiliensis*. Their use in the study of the laticiferous system. Typology of functioning production mechanisms. Effects of stimulation. *In*: *IRRDB Physiology and Exploitation Meeting*, Hainan, 1986, Pan Yanqing and Lhao Canwen Eds, South China Academy of Tropical Crops (Hainan) 136-157.

24. RAGHAVENDRA A. S., 1991. Latex Exudation from Rubber Tree, *Hevea brasiliensis. In*: *Physiology of trees* - ed. A. S. Raghavendra. New York: John Wiley.

25. SETHURAJ M.R., 1981. Yield components in *Hevea brasisliensis. Plant cell and environment* **4**, 81- 83.

26. TEMPLETON J.K., 1969. Partition of assimilates. *Journal of Rubber Research Institute of Malaya* **21**, 259-273.

27. WYCHERLEY P.R., 1976. Tapping and partition. *Journal of Rubber Research Institute of Malaysia* **24 (4)**, 169-194.

TABLE I. PRODUCTION OF RUBBER AND SENSITIVITY OF TAPPING PANEL DRYNESS OF GT 1 (EXPERIMENT 1)

Treatment	Production of rubber between 1984 and 1994		Tapping panel dryness (%)			
	TNT*	g / t Cumulated	PDR*		TDR*	
			Start	End	Start	End
Opening at 30 cm of girth or at 3 years 5 months	780	24903 b	0.3 b	26.6 a	0.0	1.4 d
Opening at 35 cm of girth or at 3 years 10 months	734	26061 b	0.0 b	25.1 a	0.0	8.9 a
Opening at 40 cm of girth or at 4 years 4 months	708	28500 a	2.4 a	19.5 b	0.0	5.6 b
Opening at 45 cm of girth or at 4 years 9 months	676	29705 a	0.3 b	17.7 b	0.0	3.4 c
Opening at 50 cm of girth or at 5 years 9 months	598	29829 a	3.0 a	14.1 c	0.0	3.2 c
Untapped trees (control) at 40 cm of girth	-	-	-	-	-	-

a, b, c : Treatments affected by the same letter are not significantly different (test of Scheffe at 5 %)

All treatments are tapped in tapping system as ½ S d/4 6d/7 i.e. 78 tappings per year

* TNT: Cumulative Total Number of tapping during ten years of tapping

* PDR: Rate of partially dry tree i.e. partially dry tapping cut

* TDR: Rate of totally dry tree i.e. totally dry tapping cut

TABLE III. PRODUCTION OF RUBBER AND SENSITIVITY OF TAPPING PANEL DRYNESS OF PB 217 (EXPERIMENT 2)

Treatment	Production of rubber between 1988 and 2001			Tapping panel dryness (%)			
	TNT*	g / a		PDR*		TDR*	
		Mean	Cumulated	Start	End	Start	End
Opening at 50 cm of girth or at 6 years 10 months	936	9614 a	69367 b	0.9 a	0.0 c	0.0	3.2 b
Opening at 55 cm of girth or at 7 years 4 months	888	9522 a	73762 a	0.3 b	10.0 ab	0.0	6.8 a
Opening at 60 cm of girth or at 8 years 3 months	834	7429 b	70349 b	0.0 b	11.9 a	0.0	3.2 b
Opening at 65 cm of girth or at 8 years 10 months	780	7772 b	69494 b	-	8.3 b	0.0	0.0 c

a, b, c : Treatments affected by the same letter are not significantly different (test of Scheffe at 5 %)

All treatments are tapped in tapping system as ½ S d/4 6d/7 i.e. 78 tappings by year

* TNT: Cumulative Total Number of tapping during thirteen years of tapping

* PDR: Rate of partially dry tree i.e. partially dry tapping cut

* TDR: Rate of totally dry tree i.e. totally dry tapping cut

TABLE IV. PRODUCTION OF RUBBER AND SENSITIVITY TO TAPPING PANEL DRYNESS OF CLONE PB 235 (EXPERIMENT 3)

Treatment	Production of rubber between 1991 and 2001	Tapping panel dryness (%)				
	TNT*	g / t	PDR*		TDR*	
		Cumulative	Start	End	Start	End
Opening at 40 cm of girth or at 4 years 11 months	774	30155 ab	1.2 a	5.0 c	0.0	3.1
Opening at 45 cm of girth or at 5 years 3 months	744	31264 ab	1.2 a	8.8 ab	0.0	3.1
Opening at 50 cm of girth or at 6 years 3 months	666	32631 a	0.6 b	10.3 a	0.0	3.2
Opening at 55 cm of girth or at 7 years	606	30715 ab	0.0 d	6.9 b	0.0	3.1
Opening at 60 cm of girth or at 7 years 6 months	570	29777 b	0.3 c	6.4 bc	0.0	3.0
Untapped trees (control) at 40 cm of girth	-	-	-	-	-	-

a, b, c: Treatments affected by the same letter are not significantly different (test of Scheffe at 5 %)

All treatments are tapped in tapping system as ½ S d/4 6d/7 i.e. 78 tappings by year

* TNT: Cumulative Total Number of Tapping during ten years of tapping

* PDR: Rate of partially dry tree i.e. partially dry tapping cut

* TDR: Rate of totally dry tree i.e. totally dry tapping cut

TABLE II. PRODUCTION OF RUBBER AND SENSITIVITY OF TAPPING PANEL DRYNESS OF GT 1 (EXPERIMENT 5)

Treatment	Production of rubber between 1992 and 2001		Tapping panel drynes (%)			
	TNT*	g / a Cumulated	PDR*		TDR*	
			Start	End	Start	End
Opening at 40 cm of girth or at 6 years	687	30127 a	0.0 b	6.1 b	0.0	3.0 c
Opening at 45 cm of girth or at 6 years 10 months	615	29430 ab	0.3 a	0.3 c	0.0	0.0 c
Opening at 50 cm of girth or at 7 years 9 months	543	25722 bc	0.0 b	10.0 a	0.0	15.2 a
Opening at 60 cm of girth or at 9 years 10 months	387	24767 c	0.0 b	5.6 b	0.0	9.1 b
untapped trees (control) at 40 cm of girth	-	-	-	-	-	-

a, b, c : Treatments affected by the same letter are not significantly different (test of Scheffe at 5 %)

All treatments are tapped in tapping system as ½ S d/4 6d/7 i.e. 78 tappings by year

* TNT: Cumulative Total Number of tapping during nine years of tapping

* PDR: Rate of partially dry tree i.e. partially dry tapping cut

* TDR: Rate of totally dry tree i.e. totally dry tapping cut

TABLE V. PRODUCTION OF RUBBER AND SENSITIVITY OF TAPPING PANEL

DRYNESS OF PB 235 (EXPERIMENT 4)

Treatment	Production of rubber between 1992 and 2001				Tapping panel dryness (%)			
	TNT*	g / t Cumulated	kg / ha Mean	kg / ha Cumulated	PDR*		TDR*	
					Start	End	Start	End
Opening at 50 cm of girth or at 5 years 10 months	701	31223 a	1882	11778 a	1.25 b	10.8 ab	0.3 b	6.5 a
Opening at 60 cm of girth or at 7 years 10 months	545	25545 b	2064	8254 b	1.38 b	12.8 a	0.5 b	4.9 a
Opening at 70 cm of girth or at 9 years 10 months	389	30675 c	1999	6567 c	5.45 a	8.1 bc	3.3 a	7.0 a

a, b, c : Treatments affected by the same letter are not significantly different (test of Scheffe at 5 %)

All treatments are tapped in tapping system as ½ S d/4 6d/7 i.e. 78 tappings by year

* TNT: Cumulative Total Number of tapping during nine years of tapping

* PDR: Rate of partially dry tree i.e. partially dry tapping cut

* TDR: Rate of totally dry tree i.e. totally dry tapping cut